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Mechanics of Arteriomesenteric Duodenal Obstruction and Direct Surgical Attack Upon Etiology *

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THE CONCEPT that there are clinical cases of partial to complete duodenal obstruction caused by extrinsic pressure of the superior mesenteric artery is discussed in standard texts. Partpilio [1] devotes most of a chapter to the subject and presents an extensive bibliography. With this concept as a starting point, theory may be extended on an anatomico-mechanical basis. This report is an attempt to carry such theory to a logical conclusion and to present a surgical attack upon the mechanical cause of this type of obstruction.

In its transverse or ascending portion, depending on individual variation, the duodenum usually lies in an acute vascular angle between the aorta and the superior mesenteric artery. If we could liken the superior mesenteric artery to a surveyor's plumb-line and the weight of the small bowel and its mesentery to the plumb-bob, then the superior mesenteric artery-aortic angle would approach 90° in the quadruped and less than zero degrees in the human with normal lumbar lordosis. Obviously, evolution would have stopped short of the biped human if erect posture in itself resulted in duodenal occlusion. There are multiple anatomico-mechanical factors involved in this theoretical type of obstruction.

The axis of the superior mesenteric arterial trunk is directed, in the frontal plane, from its origin on the aorta to the right deep pelvic brim so that in the sagittal plane it lies anterior to the aorta only in its proximal portion. The aorta is the most prominent feature of the midposterior abdominal cavity. There are less prominent and less unyielding structures to either side. Thus, although the superior mesenteric artery-aortic vascular angle be quite acute in the sagittal plane, the same angle in the frontal plane might allow ample room for the doudenum to pass behind the superior mesenteric artery and anterior to the vena cava (Fig. 7). From a mechanical standpoint, the important factor is not so much the acuity of the vascular angle in the sagittal plane but at what point is this angle the traverse of the duodenum lies.

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The duodenum may terminate at the duodenojejunal flexure before reaching the right border of the aorta. In less than half of Piersol's [2] cases did this flexure lie to the left of the aorta and in about ten per cent of his cases the duodenum lay "wholly on the right of the aorta." Thus, in some individuals it is not anatomically possible for the duodenum to be compressed between the aorta and the superior mesenteric artery in the sagittal plane.

The descending, transverse and ascending portions of the duodenum describe a curve which may vary from a wide shallow "U" to a sharp "V". In the "U" type, if the superior mesenteric artery crosses the base of the "U", the ascending limb may pass to the left, anteriorally and upward over the aorta to an attachment to the left of the aorta without vascular compression. In the "V" type, even though the superior mesenteric artery crosses the base of the "V", the ascending limb may pass upward under the superior mesenteric artery toward the apex of the vascular angle of its origin before crossing the aorta so that there is mechanical potential for vascular compression (Fig. 6). In this connection, it is best to visualize superior mesenteric artery duodenal compression against the aorta in a plane 45° to the right of the sagittal or 45° anterior to the frontal planes. The compression is between the superior mesenteric artery and the right antero-lateral surface of the aorta.

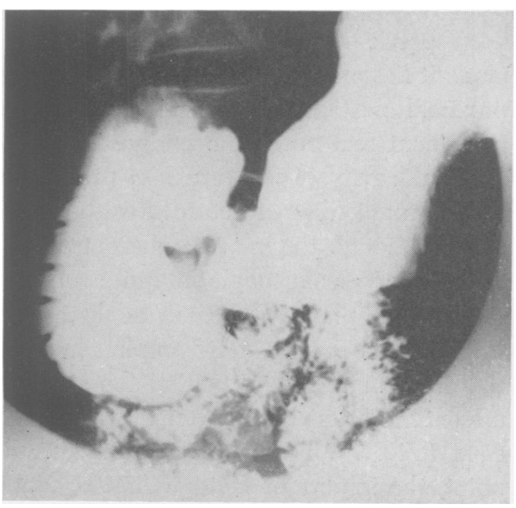

FIG. 1. Upper gastro-intestinal x-ray in case of arteriomesenteric obstruction of transverse duodenum illustrating distention of first, descending and transverse portion of duodenum.

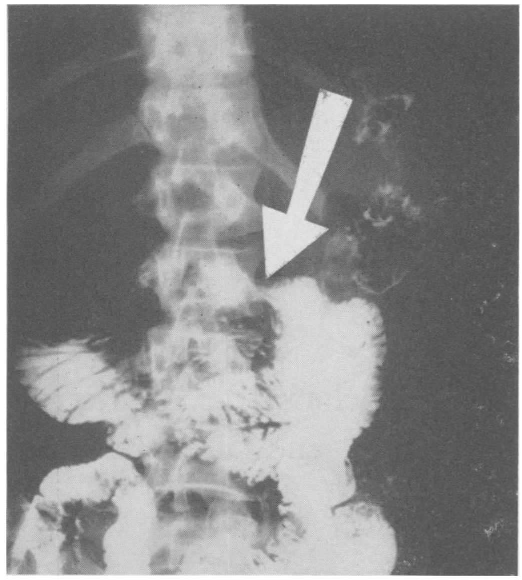

FIG. 2. Upright preoperative gastro-intestinal x-ray. Arrow indicates point interpreted by radiologist as level of duodeno-jejunal angle at the mid second lumbar vertebral body.

The blood supply to the transverse and ascending portions of the duodenum is derived from the superior mesenteric artery as is that of the remainder of the embryological midgut. To the right of the superior mesenteric artery, the branches of the inferior pancreaticoduodenal artery enter the "mesenteric" side of the duodenum along its superior aspect. To the left of the traverse of the duodenum by the superior mesenteric artery, the blood supply enters the "mesenteric" side of the duodenum on its inferior aspect (Fig. 8). The blood supply entering the "mesenteric" side of the duodenum posterior to the traverse of the superior mesenteric artery is on its anterior aspect. From the standpoint of mesenteric attachment the third and fourth portions of the duodenum display, in their short length, 180° of clockwise longitudinal torsion. This is the result of the counter-clockwise torque, or force, exerted upon it by the embryological rotation of the entire midgut. Like a ball on a string swinging in a circle, the axis of any cross-sectional plane of small bowel remains constantly oriented as regards its "string" or mesenteric attachment. But with reference to other fixed anatomic points, this axis rotates just as the axis of the ball rotates with reference to the ground.

Because of the 180° of longitudinal torsion, it is the avascular anti-mesenteric surface of the duodenum which comes to lie against the pancreas to the left of the superior mesenteric artery. The union of these two viscera is merely one of embryologically fused peritoneal surfaces. The duodenojejunal angle is fixed by the Trietz ligament. The left side of the embryologic midgut pre-arterial mesentery, having rotated 270° in a counter-clockwise direction in a plane vertical to the dorsal coelom, and 90° in the sagittal plane, lies against the posterior abdominal cavity and embryological fusion of appositional peritoneal surfaces has occurred. At the point of traverse of the duodenum by the superior mesenteric artery and its mesentery, the duodenum is bounded inferiorally by a vascular sling. The vessels are the intestinal branches to the terminal duodenum and the proximal jejunum.

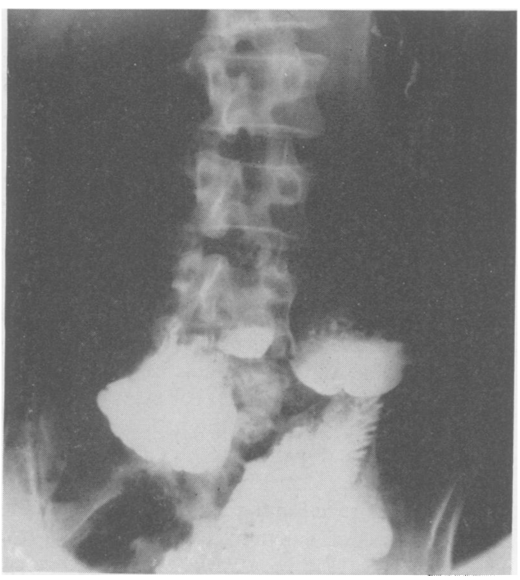

Fig. 3. Gastro-intestinal x-ray on 12th postoperative day 25 minutes after barium ingestion. Duodenum still dilated.

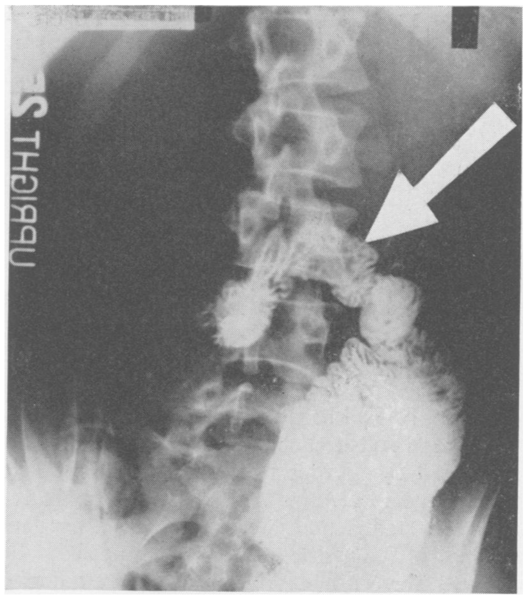

Fig. 4. Upright gastro-intestinal x-ray four months postoperative 25 minutes after barium ingestion. Arrow points to level of duodenojejunal angle now at level of mid third lumbar vertebral body. See Figure 2.

Of the foregoing anatomico-mechanical variables only the factor of immobilization of the terminal duodenum lends itself to direct surgical alteration or correction. Bypass operations give symptomatic relief of duodenal stasis but neither prove nor disprove a purely mechanical etiology. Other than the fact that part of the duodenum lies between the aorta and the superior mesenteric artery (in one plane or another), the most important mechanical factor is its anatomic immobilization. Surgical mobilization of the duodenum to the left of its traverse by the superior mesenteric artery should release the bowel from the most acute portion of the superior mesenteric artery-aortic vascular angle. If such mobilization results in improved duodenal emptying, then the theoretical etiology of this type of duodenal obstruction might better be placed in the mechanical, then in the physiologic or psychosomatic realm. Such an attack was undertaken in the following case.

Case Report

Mr. J., a 30-year-old yardman, was admitted to Southern Pacific General Hospital on October 25, 1956, with complaints of weight loss, progressive indigestion and abdominal pains of 1 year's duration. He had been unable to work for 1 month prior to hospitalization and stated he had been "bothered by nervous indigestion" as long as he could remember. About a year prior to hospitalization this "indigestion" developed into a constant feeling of epigastric fullness accompanied by nausea. These symptoms were aggravated during working hours, were partially relieved by rest and antacids, and did not interfere with sleep. There was rare emesis, but when vomiting occurred it was copious and particles of food eaten 12 or more hours earlier were identified. Two months before admission the sensation of epigastric fullness began to be followed by cramping upper abdominal pains with dull aching and sharp stabbing extension along the right costal margin and up along the sternum. Body weight of 160 lbs. a year before had fallen to 130 lbs. at the time of admission.

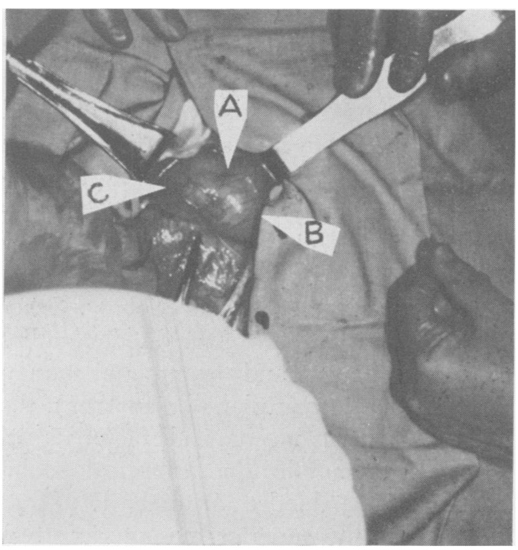

FIG. 5. Dilated appearance of pyloric region at surgery in case of arteriomesenteric duodenal obstruction. A: pylorus. B: gastric antrum. C: first portion of duodenum. Compare with Figure 1.

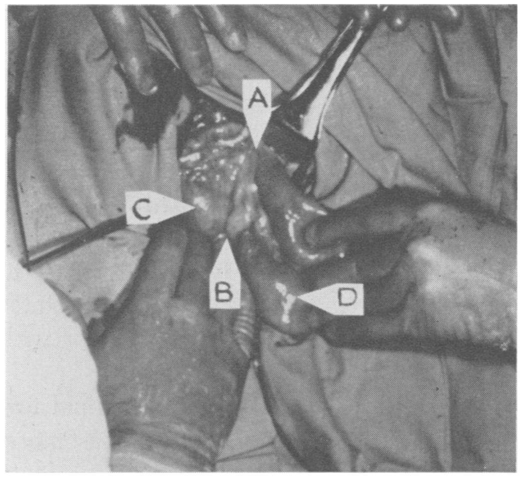

FIG. 6. Operative field in case of arteriomesenteric duodenal obstruction. Superior mesenteric artery and mesentery crosses field almost vertically on a line from Ligament of Trietz (A) to (B). Dilated transverse duodenum (C) passes under superior mesenteric artery and mesentery and ascends vertically beneath it to duodenojejunal angle (A). Loop of jejunum held by assistant's left hand (D). Transverse colon at top.

Past and family history and system review were unremarkable.

The patient was 6′ 2″ tall, weighed 130 lbs., had a blood pressure of 125/80 and displayed no unusual physical findings other than his obvious state of malnutrition.

Laboratory examination was considered normal other than for gastro-intestinal x-ray studies which were interpreted as follows: "The barium passes into a large stomach. The first and second portions of the duodenum are enlarged. A definite dilatation of the second portion of the duodenum is present, possibly caused by bands or adhesions or a superior mesenteric artery (Fig. 1). The stomach empties in 4 hrs. and there appears to be a trace of barium in the first portion of the duodenum at this time."

A diagnosis was made of the condition described as chronic duodenal stasis secondary to compression of the duodenum by the superior mesenteric artery. The theoretical mechanics of his condition were explained to the patient and he was advised to take a period of sick leave and try conservative treatment. He returned in three weeks statedly unimproved and requested surgical intervention. A second gastro-intestinal series of x-rays in November 1956 confirmed the presence of dilatation of the duodenum around to the anatomic location of superimposition by the superior mesenteric artery.

FIG. 8. Further traction on loop of jejunum as in Figure 7. Sponge stick, on pancreas, indicates level of Ligament of Trietz. Operator's index finger now at right of vena cava, aorta at left against retractor. Illustrates blood supply to duodenojejunal angle at inferior border of bowel.

Laparotomy, with an unclamped nasogastric Levine tube in place, mirrored the x-ray appearance of the upper abdominal gastro-intestinal tract. There was slight gastric distention. The pylorus was distended to a diameter of 4 to 5 cm. (Fig. 5). The duodenum was dilated to the point where it passed under the superior mesenteric artery at the junction of its transverse and ascending portions (Fig. 6). The curve of the duodenum was of the "V" type. None of the duodenal fossae were abnormal and no gross or mechanical cause for the abrupt change from dilated to normal calibre of the duodenum could be identified other than the coincident superimposition of the superior mesenteric artery and its mesentery.

The ligament of Trietz was cut across including its enveloped strand of grossly recognizable muscle. This incision was carried medially in two limbs by incising the embryologic lines of peritoneal fusion, both antero-superiorly between duodenum and pancreas and postero-inferiorly between duodenum and posterior parietal peritoneum. The incisions were extended to a point nearly underlying the traverse of the superior mesenteric artery. Blunt dissection of the avascular and delicate connective tissue between the superior surface of the duodenum and inferior surface of the pancreas readily separated the fourth portion of the former viscus from the body of the latter. Reperitonization was by a simple running suture starting at the stump of Trietz' ligament and joining the anterior and posterior lines of peritoneal incision along the pancreas to the medial extremity of these incisions, then continuing back lengthwise along the 4th

FIG. 7. Loop of jejunum held by assistant in Figure 6 turned to right, with sponge stick marking Ligament of Trietz. Operator's index finger in vascular sling of superior mesenteric artery (A); mesentery with superior mesenteric artery on volar and aorta on dorsal side of finger. Illustrates frontal plane width of superior mesenteric artery-aortic vascular angle at level of transverse duodenum.

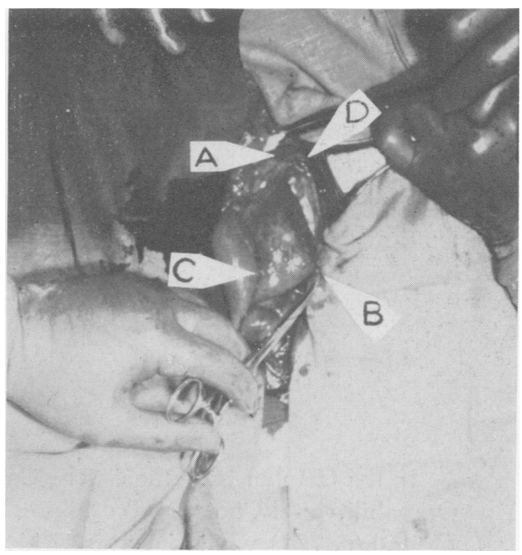

FIG. 9. Ligament of Trietz and peritoneal attachments of ascending portion of duodenum sectioned and duodenojejunal angle mobilized from (A) to (B). Crease across proximal jejunum is artifact due to traction for exposure (C). Note inferior mesenteric vein crossing aorta at level of section of Ligament of Trietz (D).

portion of the duodenum to the point of its former attachment to Trietz' ligament. The affected portion of the pancreas remained "retroperitoneal" while the 4th portion of the duodenum was transformed into an "intraperitoneal" organ. Fixation at the duodenojejunal angle was abolished.

Postoperative recovery was uneventful aside from emesis on three occasions. Gastro-intestinal x-rays on the 12th postoperative day indicated no definite alteration in duodenal dilatation but the radiologist noted that "barium is passing rapidly through this part." The patient described remission of epigastric fullness and upper abdominal and parasternal pains. He was discharged and allowed to return to work in his 6th postoperative week.

Four and one-half months after operation, the patient returned for follow up x-ray studies. He stated he was free of all his symptoms, had not lost a day of work, was able "to eat anything" and had gained 42 lbs. Gastro-intestinal x-rays in April 1957 showed 25-minute gastric emptying with most of the barium in the small intestine and the radiologist concluded, "The first, second and third portions of the duodenum are now functioning in a normal manner. There is still slight dilatation of the second portion."

Surgical mobilization of the ascending duodenum resulted in radiologic relocation of the duodenojejunal angle from the level of the second to the third lumbar vertebral body (Fig. 2, 4).

Summary

A combination of anatomico-mechanical variables must occur in a single individual before extrinsic pressure between the aorta and the superior mesenteric arterio-mesentery may potentiate occlusion in the duodenum. Symptoms become manifest with gradual physiologic decompensation of the compressed viscus. Where duodenal obstruction of this type does occur the point of compression is not at the actual traverse of the duodenum by the superior mesenteric artery but to the left of this point, the ascending limb of the duodenum being compressed between the superior mesenteric artery and the anterior right lateral aspect of the aorta. The involved portion of the duodenum is immobilized in the constricting vice of these two vessels by its peritoneal attachments and the ligament of Treitz. Surgical section of these structures and mobilization of the ascending duodenum is readily accomplished.

Conclusion

Surgical mobilization of the ascending duodenum resulted in rapid reversal of symptomatology and of radiologic evidence of arteriomesenteric duodenal obstruction in the case presented. Anticipated results in a single case do not imply proof but do allow presentation of the theoretical anatomico-mechanical factors involved in this type of obstruction.

Bibliography

1. Partpilio, A. V.: Surgical Technic. Philadelphia, Lea & Febiger, 1949, p. 340.
2. Piersol, George A.: Human Anatomy, 1644, 1930.

Correction

In the October issue the article, Carcinoma of the Pancreatico Duodenal Area: Operability and Choice of Procedure, by Milton R. Porter, includes an illustration (Fig. 4, p. 722) which incorrectly identifies the jejunum as Duod.